Trade Booms, Trade Busts, and Trade Costs*

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Abstract
What has driven trade booms and trade busts in the past and present? Using a micro-founded measure of trade frictions derived from a standard gravity framework, we gauge the importance of bilateral trade costs in determining international trade flows. We construct a new balanced sample of bilateral trade flows for 130 country pairs across the Americas, Asia, Europe, and Oceania for the period from 1870 to 2000 and demonstrate an overriding role for declining trade costs in the pre-World War I trade boom. In contrast, for the post-World War II trade boom we identify changes in output as the dominant force. Finally, the entirety of the interwar trade bust is explained by increases in trade costs.

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I. Introduction

What has driven trade booms and trade busts in the past and present? The goal of this paper is to address this question head-on by examining new data on bilateral trade flows for a consistent set of 130 country pairs over the period from 1870 to 2000. In so doing, we invoke the gravity equation to help us resolve the issue. But is it really possible to explain the growth of world trade under a single framework, given that the consensus view suggests widely divergent explanations for trade—from the relative resource endowment view of the nineteenth century to the present day rise of Ricardian models of trade? In other words, does one empirical model of trade really fit all?

Our answer is yes for the following reasons. Inevitably, any long-run view of international trade will face the problem that the structure of economies has changed over time. But what has not changed is the fact that bilateral trade is driven by global factors common across all countries, factors within particular countries, and factors specific to country pairs. However, standard models of international trade, under any plausible assumptions about the patterns of specialization and production, generate identical empirical predictions about these three forces. The basic intuition is that gravity is simply an expenditure equation, and expenditure equations arise in any general equilibrium model. What is more, any properly specified estimating equation should be able to reasonably accommodate changes in these factors over time.

Throughout, our key organizing principle is that the growth of world trade is driven by two primary forces: changes in output and changes in the aggregate trade costs facing countries on international markets. Trade costs are all the costs of transaction and transport associated with the exchange of goods across national borders. These barriers to trade have long been marginalized in conventional trade theory in favor of the analysis of technological or factor endowment theories of comparative advantage. And even though trade costs are currently of great interest (James E. Anderson and Eric van Wincoop, 2004; Maurice Obstfeld and Kenneth S. Rogoff, 2000; David Hummels, 2007), little is known about the magnitude, determinants, and consequences of trade costs.

However, an established literature in the new comparative economic history has provided us with a rough outline of the size and long-run trajectory of several key components of trade costs. For example, recent research on the nineteenth century trade boom has tracked freight rates and tariffs (Michael A. Clemens and Jeffrey G. Williamson, 2001; David S. Jacks and Krishna Pendakur, 2009; and Saif I. Shah Mohammed and Williamson, 2004). Likewise, Barry Eichengreen and Douglas A. Irwin (1995) and Antoni Estevadeordal, Brian Frantz, and Alan M. Taylor (2003) have documented evidence on frictions during the interwar period while Irwin (1995) and Hummels (2007) have done much the same for the post-World War II period. However, the relative size and impact of a host of other important impediments to trade that are hard to measure like informational, institutional, and non-tariff barriers remain unexplored. There has also been very little work on consistently measuring barriers to trade over the last two waves of globalization and the one intervening spell of deglobalization. This paper is the first step in filling the gap on both counts of comprehensiveness and consistency.

Specifically, we present a micro-founded measure of aggregate trade costs consistent with a very general class of international trade models. We derive this measure from a multiple-country general equilibrium model of trade in differentiated goods based on the approach of Dennis Novy (2008). The innovation of this approach is to control for multilateral barriers in a tractable, yet previously un-noticed way which makes it possible to compute the implied trade costs solely on the basis of bilateral trade, total trade, and output data. This implied trade cost wedge gauges the difference between observed and frictionless bilateral trade. Thus, we are able to estimate the combined magnitude of tariffs, transportation costs, and all other macroeconomic frictions that impede international trade but which are inherently difficult to observe. We emphasize that this approach of inferring trade costs from readily available data on trade and GDP holds clear advantages for applied research: the constraints on enumerating—much less, collecting data on—every individual trade cost element for every individual traded good makes a direct accounting approach impossible.

We examine the growth of global trade between 1870 and 1913, its retreat from 1921 to 1939, and its subsequent resurrection from 1950 to 2000. Thus, the paper is the first to offer a complete quantitative assessment of developments in global trade from 1870 all the way to 2000.[1] Our findings first demonstrate that gravity exerts its inexorable pull in all the three sub-periods. Bilateral trade flows are found to be positively related with GDP, fixed exchange rate regimes, common languages, historical membership in European overseas empires, and shared borders but negatively related with distance. We also find that the average level of trade costs (expressed in tariff equivalent terms) for twenty-eight countries fell by thirty-three percent in the forty years before World War I. For the same countries, we find that the average level of trade costs increased by thirteen percent from 1921 to the beginning of World War II. Finally, average trade costs are shown to have fallen by sixteen percent in the years from 1950.

After examining the trends in trade costs, we turn to whether our measure of trade costs is reliable. Our evidence suggests that standard factors like geographic proximity, adherence to fixed exchange rate regimes, common languages, membership in a European empire, and shared borders all matter for explaining trade costs. These factors alone account for roughly 30 to 50

[1] We do, however, follow in the footsteps of other researchers that have looked at different periods in isolation. For instance, Estevadeordal, Frantz, and Taylor (2003) examine the period from 1870 to 1939. The work of Scott L. Baier and Jeffrey H. Bergstrand (2001) is the closest predecessor to our own. However, they only consider the period from 1958 to 1988. We also track changes in trade due to all trade costs while their data contained only rough proxies for freight costs and tariffs.

percent of the variance in trade costs. However, the three sub-periods exhibit significant differences, allowing us to document important changes in the global economy over time: the growing importance of distance in determining the level of trade costs and the diminishing effects of fixed exchange rate regimes and membership in European empires on trade costs over time.

Returning to the question of what drives trade booms and busts, we use our micro-founded gravity equation to attribute changes in global trade to two fundamental forces: changes in global output and changes in trade costs. For the pre-World War I period, we find that trade cost declines explain roughly sixty percent of the growth in global trade. And consistent with previous studies for the post-World War II period (see Baier and Bergstrand, 2001; John Whalley and Xian Xin, 2007), we find that only thirty-one percent of the present-day global trade boom can be explained by the decline in trade costs. Finally, the precipitous rise in trade costs following the Great Depression explains the entire interwar trade bust.

II. Gravity in Three Eras of Globalization

One of the oft-repeated truisms of the gravity literature is its success in predicting the dimensions and directions of international trade flows. What is more, its champions can point to the substantial theoretical underpinnings which have been added to—or at least made consistent with—the gravity model of trade in the past thirty years. From its earliest formulations in the works of Pentti Pöyhönen (1963) and Jan Tinbergen (1961), the gravity equation for describing international trade flows held a tenuous position. Undoubtedly, there was a certain intuitive appeal with the equation's clean empirical validation and its shameless parallels to Newtonian physics, but it remained outside the standard toolkit for economists until the contributions of James E. Anderson and Jeffrey H. Bergstrand.

By assuming product differentiation by country of origin, Anderson (1979) was able to explain the multiplicative form of the equation and to allow for disaggregation down to the bilateral level. Likewise, Bergstrand (1985, 1989, 1990) in a string of papers established the applicability of the gravity equation to a number of preference and substitution structures as well as to a number of alternate models of international trade: the Heckscher-Ohlin relative factor endowments approach, the (Then) New Trade Theory based on monopolistic competition, and a hybrid model of different factor proportions among monopolistically competitive sectors. Alan Deardorff (1998, 2004) also provides justification for gravity in a Heckscher-Ohlin framework showing that bilateral versus multilateral factors matter just as in a simple model of monopolistic competition with fixed supply.

More recently, Eaton and Kortum (2002) have incorporated the gravity equation into a Ricardian model of international trade while Thomas Chaney (2008) has extended gravity in-to the realm of the (Now) New Trade Theory based on heterogeneous firms. Thus, the circle has been completed with gravity now having been found consistent with *all* the dominant theories of international trade. These theories also produce gravity equations for bilateral trade with a very similar structure as we show below. And while this may make empirical validation of any particular theory of international trade difficult at times (Robert C. Feenstra, James R. Markusen, and Andrew K. Rose, 2001; Simon J. Evenett and Wolfgang Keller, 2002), it leaves researchers with a clean empirical framework for evaluating the growth of world trade. To a first approximation, bilateral trade growth can be attributed to changes in the global trading environment which affect all countries proportionately—for instance, global economic growth which stimulates international trade; changes in the characteristics of individual countries—for instance, changes in domestic productivity[2]; and changes at the bilateral level including the trade costs facing individual country-pairs—for instance, the introduction of a fixed exchange rate regime between two countries.

Turning to the empirical success of the gravity model, an ever expanding literature documents the applicability of gravity through time. In chronological order, we can point to the recent work of Olivier Accominotti and Marc Flandreau (2006) who offer some of the earliest evidence by considering bilateral trade flows in the period from 1850 to 1870, finding little role for the bilateralism of the day in promoting trade flows. Likewise, J. Ernesto López-Córdova and Christopher M. Meissner (2003), Jacks and Pendakur (2009), and Kris J. Mitchener and Marc D. Weidenmier (2008) all employ extensive datasets in the period from 1870 to 1913 to discern the effects, respectively, of the classical gold standard, the maritime transport revolution, and the spread of European overseas empires on bilateral trade flows.

For the interwar period, Eichengreen and Irwin (1995) are able to document the formation of currency and trade blocs by using an early variant of gravity while Estevadeordal, Frantz, and Taylor (2003) trace the rise and fall of world trade over the longer period from 1870 to 1939, offering a revisionist history where the collapse of the resurrected gold standard and the increase in maritime freight costs all play a role in explaining the interwar trade bust. Finally, for the post-World War II period, a non-exhaustive list of nearly 100 gravity oriented papers are cataloged by Anne-Celia Disdier and Keith Head (2008). We content ourselves with citing the work of Andrew K. Rose which has ignited a firestorm of controversy surrounding the effects of currency unions (2000) and of most-favored-nation status (2004) on international trade flows. In the former case, Rose finds very strong, pro-trade effects for currency unions while he struggles

[2] Those familiar with the recent literature will note that these country specific factors also include what has come to be called multilateral resistance. We discuss this below.

to identify any differences in the level of bilateral trade which takes place between GATT/WTO members and non-members—results that are highly at odds with economists' priors as well as previous research.

It is clear that the validity of the gravity model of international trade has been firmly established both theoretically and empirically and both now and in the past. But what has been lacking is a unified attempt to exploit gravity to explain the three eras of globalization. In what follows, we present the results of just such an attempt. A typical estimating equation for a gravity model of trade takes the form of:

(1) $\ln(x_{ijt}x_{jit}) = \alpha_{it} + \alpha_{jt} + \gamma \ln(y_{it}y_{jt}) + z_{ijt}\beta + \varepsilon_{ijt}$,

where the x_{ijt} and x_{jit} terms represent bilateral exports from country i to j in time t and vice versa; the α_{it} and α_{jt} terms represent importer and exporter country fixed effects intended to capture differences in relative resource endowments, differences in productivity, and any other time-invariant country attributes which might determine a country's propensity for export activity. The y_{it} and y_{jt} terms represent gross domestic product in countries i and j . z_{ijt} is a row vector of variables representing the various frictions opposing the flow of goods between countries i and j and includes familiar standbys in the literature such as the physical distance separating countries.

We use expression (1) along with the trade and output data detailed in the appendix I to chart the course of gravity in three eras of globalization: the pre-World War I belle époque (1870-1913), the fractious interwar period (1921-1939), and the post-World War II resurgence of global trade (1950-2000). The 27 countries in our sample include Argentina, Australia, Austria, Belgium, Brazil, Canada, Denmark, France, Germany, Greece, India, Indonesia, Italy, Japan, Mexico, the Netherlands, New Zealand, Norway, the Philippines, Portugal, Spain, Sri Lanka, Sweden, Switzerland, the United Kingdom, the United States, and Uruguay. Figure 1 summarizes the sample graphically.[3] Finally, we incorporate measures for distance, the establishment of fixed exchange rate regimes, the existence of a common language, historical membership in a European overseas empire,[4] and the existence of a shared border.[5] Summary statistics and the results of this exercise of estimating gravity in the three sub-periods separately are reported in Tables 1 and 2, respectively.

In Panel A of Table 2, we hem most closely to the specification in (1) in that we include the GDP terms, the five variables proxying for trade costs mentioned above, and importer and exporter country fixed effects. The results are reassuring. The coefficients on GDP—although different across the three eras of globalization—are precisely estimated and fall within the bounds established by previous researchers. Likewise, distance is found to be negatively and significantly related with bilateral trade flows. In particular, the coefficient on distance always falls within the consensus range of -0.28 and -1.55 reported by Disdier and Head (2008). Fixed exchange rate regimes, common languages, and shared borders are all found to be positively and significantly associated with bilateral trade flows. We also note that these regressions confirm the emerging story on the pro-trade effects of empires, specifically the very strong stimulus to trade afforded by European empires in the pre-World War I period (Mitchener and Weidenmier, 2008) which slowly faded in light of the disruptions of the interwar period and the decolonization movement of the 1950s and 1960s (Keith Head, Thierry Mayer, and John Ries,

[3] This sample constitutes, on average, 72% of world exports and 68% of world GDP over the entire period. We also note that the various sub-samples are highly balanced. Given the 130 country-pairs in our sample, there are 14,820 possible bilateral trade observations of which we are able to capture fully 99.9%.

[4] For all intents and purposes, this may be thought of as an indicator variable for the British Empire. The sole exception in our sample is the case of Indonesia and the Netherlands.

[5] Another obvious candidate is commercial policy, and especially tariffs. Only one consistent measure of tariffs is available for the period from 1870 to 2000 in the form of the customs duties to declared imports ratio as in Clemens and Williamson (2001). This measure seems to be a reasonably good proxy for tariffs in the pre-World War I and interwar periods. However, after 1950 and the well-known rise of non-tariff barriers to trade, this measure becomes unreliable, sometimes registering unbelievably low levels of protection. The measure also—and somewhat paradoxically—becomes less readily available after World War II; the United Kingdom, for instance, stops reporting the level of customs duties in 1965.

2008). In addition, this simple specification explains a remarkably high percentage of the variation in bilateral trade flows for each of the separate periods as the adjusted R-squared ranges from a low of 0.75 in the belle époque period to a high of 0.88 in the period from 1950 to 2000.

A more exacting specification would be that in Panel B. Along with the familiar trade cost variables, this specification includes year fixed effects and allows the country fixed effects in Panel A to change over time. In particular, we construct separate country fixed effects for every year in the sub-samples. Thus, for the period from 1870 to 1913, there are forty-four years and 27 countries, yielding 1188 country-specific annual fixed effects. Likewise, there are 513 (=19*27) country-specific annual fixed effects for the period from 1921 to 1939 and 1377(=51*27) country-specific annual fixed effects for the period from 1950 to 2000. The justification for including such a large number of country fixed effects arises from the work of Richard Baldwin and Daria Taglioni (2006) which emphasizes the problem of controlling for multilateral barriers in a panel setting and recommends the use of time-varying country dummies to obtain identification.[6] In addition, we drop the GDP term in light of its perfect collinearity with the annual fixed effects. Once again, the sign and significance of the remaining variables is remarkably consistent between all the panels.

To conclude, the fundamental result of this section has been that gravity exerts its pull, no matter the period and no matter what the underlying drivers of trade—whether they be relative resource endowments, differences in productivity, or some combination of the two. We seem to be on firm ground when asserting the consistency of gravity in determining international trade flows, both in the past and the present. This is a key result which we argue motivates the use of a

[6] This approach was also noted in Anderson and van Wincoop (2004) as a means to control for time-varying multilateral resistance without specifying the full structural model in Anderson and van Wincoop (2003).

common gravity model of trade for the three eras of globalization. We develop this model in the following section.

III. Gravity Redux

As we demonstrate above, the standard gravity equation (1) holds up well in predicting trade flows over different periods. We now review the recent trade literature and show that a gravity equation with a structure as equation (1) can be derived from a wide range of leading trade models: (i) the Anderson and van Wincoop (2003) trade model that focuses on multilateral resistance, (ii) the Ricardian trade model by Jonathan Eaton and Samuel Kortum (2002), (iii) the trade model with heterogeneous firms by Thomas Chaney (2008), based on Marc Melitz' (2003) seminal paper, and (iv) the heterogeneous firms model by Marc Melitz and Gianmarco Ottaviano (2008) with a linear, non-CES demand structure. This juxtaposition of leading trade models confirms the universal appeal of the gravity equation. That is, although the driving forces behind international trade differ across these models—that is, Ricardian comparative advantage versus love of variety, they all predict a gravity structure as an equilibrium for international expenditure patterns.

Gene Grossman (1998, p. 29-30) summarizes this situation nicely: "Specialization lies behind the explanatory power [of the gravity equation], and of course some degree of specialization is at the heart of any model of trade…This is true no matter what supply-side considerations give rise to specialization, be they increasing returns to scale in a world of differentiated products, technology differences in world of Ricardian trade, large factor endowment differences in a world of Heckscher-Ohlin trade, or (small) transport costs in a world of any type of endowment-based trade." [Emphasis in original]

In a second step, we exploit the fact that these trade models predict the same gravity structure. In particular, we formally show that all the gravity equations can be solved for implied trade costs. These implied trade costs can be interpreted as the wedge between a hypothetical frictionless world as predicted by each model and the actual trade patterns observed in the data. We argue that these implied trade costs are an informative summary statistic to describe international trade frictions. In a later section, we also demonstrate this empirically.

(i) Gravity in Anderson and van Wincoop (2003)

Anderson and van Wincoop (2003) derive the following gravity equation:

$$(2)\quad x_{ij} = \frac{y_i y_j}{y^W}\left(\frac{t_{ij}}{\Pi_i P_j}\right)^{1-\sigma},$$

where y^W is world output and Π_i and P_j are outward and inward multilateral resistance variables. The latter can be interpreted as average trade barriers. $t_{ij} \geq 1$ is the bilateral trade cost factor (one plus the tariff equivalent). $\sigma > 1$ is the elasticity of substitution. In empirical applications, trade costs t_{ij} are typically proxied by bilateral distance and a border dummy. But it is difficult to find empirical proxies for the multilateral resistance variables. Anderson and van Wincoop (2003) caution against the use of price indices since it is unclear to what extent price indices capture non-pecuniary trade barriers such as bureaucratic red-tape. The procedure that has been adopted most frequently in recent gravity applications is to include country fixed effects.

As an alternative, we eliminate the multilateral resistance variables from the gravity equation in the following manner. The counterpart of equation (2) for domestic trade x_{ii} is:

(3) $$x_{ii} = \frac{y_i y_i}{y^W}\left(\frac{t_{ii}}{\Pi_i P_i}\right)^{1-\sigma}.$$

When equation (2) is multiplied by its counterpart for bilateral trade from *j* to *i*, x_{ji}, we obtain the product of all multilateral resistance variables on the right-hand side, $\Pi_i \Pi_j P_i P_j$. These multilateral resistance indices can be eliminated by dividing by the product of domestic trade flows, $x_{ii} x_{jj}$:

(4) $$\frac{x_{ij} x_{ji}}{x_{ii} x_{jj}} = \left(\frac{t_{ij} t_{ji}}{t_{ii} t_{jj}}\right)^{1-\sigma}.$$

Equation (4) can be rewritten in gravity form as

(5) $$\ln\left(x_{ij} x_{ji}\right) = \ln\left(x_{ii} x_{jj}\right) + (1-\sigma)\ln\left(t_{ij} t_{ji}\right) + (\sigma-1)\ln\left(t_{ii} t_{jj}\right) + \varepsilon_{ij},$$

where the error term ε_{ij} has been added.

We solve for the trade costs as the key parameters of interest. The parentheses on the right-hand side of equation (4) contain the product of two trade cost ratios. These ratios represent the extent to which bilateral trade costs t_{ij} and t_{ji} exceed domestic trade costs t_{ii} and t_{jj}. Finally, we take the square root to form their geometric average and subtract by one to get an expression for the tariff equivalent. The resulting expression is

(6) $$\tau_{ij} \equiv \left(\frac{t_{ij} t_{ji}}{t_{ii} t_{jj}}\right)^{\frac{1}{2}} - 1 = \left(\frac{x_{ii} x_{jj}}{x_{ij} x_{ji}}\right)^{\frac{1}{2(\sigma-1)}} - 1,$$

where τ_{ij} is our micro-founded trade cost wedge.

To grasp the intuition behind this trade cost measure, imagine the two extremes of a frictionless world and a closed economy. In a frictionless world all trade cost factors t_{ij}, t_{ji}, t_{ii} and t_{jj} are equal to 1. It follows that $\tau_{ij} = 0$. In contrast, a closed economy is characterized by bilateral trade flows, $x_{ij}x_{ji}$, that are zero. In that case, τ_{ij} approaches infinity. τ_{ij} can therefore be interpreted as a trade cost wedge that measures just how far bilateral trade integration is away from a hypothetical frictionless world. Note that this trade cost measure does not impose bilateral trade cost symmetry, $t_{ij} = t_{ji}$. Bilateral trade costs, t_{ij} and t_{ji}, may differ under this framework but here, we can only identify their geometric average and not the extent to which they diverge. In addition, we do not impose zero domestic trade costs.

We have derived the trade cost measure in equation (6) from the well-known Anderson and van Wincoop (2003) trade model. Arguably, that model is one of the most parsimonious trade models of recent years. In line with the Armington assumption, countries are endowed with differentiated goods and trade is driven by consumers' love of variety, represented by standard Dixit-Stiglitz preferences. To show that our trade cost measure τ_{ij} is not dependent on one specific trade model, we now derive this measure from other leading trade models.

(ii) Gravity in Eaton and Kortum (2002)

In the Ricardian model by Eaton and Kortum (2002), productivity in each country is drawn from a Fréchet distribution that has two parameters, T_i and ζ. T_i determines the location of the productivity distribution for country *i*, with a high T_i denoting high overall productivity. $\zeta > 1$ denotes the variation of productivity across goods and is treated as common across countries, with a high ζ denoting little variation. The model yields a gravity equation for an aggregate of homogeneous goods whose structure is related to equation (2). It is given by

$$(7)\quad \frac{x_{ij}}{x_j} = \frac{T_i \left(c_i t_{ij}\right)^{-\zeta}}{\sum_i T_i \left(c_i t_{ij}\right)^{-\zeta}},$$

where x_j denotes country *j*'s total expenditure. c_i denotes the input cost in country *i*.

As in the context of the Anderson and van Wincoop (2003) model, we are interested in the trade cost parameters. T_i and c_i are unobservable but cancel out once the ratio of domestic over bilateral trade flows is formed as in equation (6). This yields

$$(8)\quad \tau_{ij}^{EK} = \left(\frac{t_{ij}t_{ji}}{t_{ii}t_{jj}}\right)^{\frac{1}{2}} - 1 = \left(\frac{x_{ii}x_{jj}}{x_{ij}x_{ji}}\right)^{\frac{1}{2\zeta}} - 1.$$

Comparing equations (6) and (8), it is obvious that $\tau_{ij}^{EK} = \tau_{ij}$ if $\zeta = \sigma - 1$. For more details on the comparison of Armington-type and Ricardian models, see Eaton and Kortum (2002, footnote 20) and Anderson and van Wincoop (2004, pp. 709-710). Note that the Eaton and Kortum (2002) model therefore also implies a gravity structure as in equation (5), namely

$$(9)\quad \ln\left(x_{ij}x_{ji}\right) = \ln\left(x_{ii}x_{jj}\right) - \zeta\ln\left(t_{ij}t_{ji}\right) + \zeta\ln\left(t_{ii}t_{jj}\right) + \varepsilon_{ij}.$$

(iii) Gravity in Chaney (2008)

Chaney (2008) builds on the seminal paper by Melitz (2003) and derives a gravity equation based on a model with heterogeneous productivities across firms and fixed costs of exporting. In contrast to standard trade models, the two assumptions of heterogeneous firms and fixed costs of exporting introduce an extensive margin of trade. Not only do exporters vary the size of shipments (the intensive margin) in response to changes in trade costs, but also the set of exporters changes (the extensive margin). Chaney derives the following industry-level gravity equation

$$(10)\quad x_{ij} = \frac{y_i y_j}{y^W}\left(\frac{w_i t_{ij}}{\lambda_j}\right)^{-\gamma}\left(f_{ij}\right)^{-\left(\frac{\gamma}{\sigma-1}-1\right)},$$

where w_i is workers' productivity in country *i*, λ_j is a remoteness variable akin to multilateral resistance, and f_{ij} are the fixed costs of exporting from country *i* to *j*. γ is the shape parameter of the Pareto distribution from which the productivities are drawn, with a high γ denoting a low degree of heterogeneity and $\gamma > \sigma - 1$. Forming the ratio of domestic over bilateral trade flows yields

$$(11)\quad \tau_{ij}^{Ch} = \left(\frac{t_{ij}t_{ji}}{t_{ii}t_{jj}}\right)^{\frac{1}{2}} \left(\frac{f_{ij}f_{ji}}{f_{ii}f_{jj}}\right)^{\frac{1}{2}\left(\frac{1}{\sigma-1}-\frac{1}{\gamma}\right)} - 1 = \left(\frac{x_{ii}x_{jj}}{x_{ij}x_{ji}}\right)^{\frac{1}{2\gamma}} - 1.$$

τ_{ij}^{Ch} is a now function of both variable and fixed trade costs. Thus, under the assumptions of Chaney's (2008) model the interpretation of the trade cost wedge extends to fixed costs of international trade. Equation (11) implies the gravity structure

$$(12)\quad \ln\left(x_{ij}x_{ji}\right) = \ln\left(x_{ii}x_{jj}\right) - \gamma\left(\ln\left(t_{ij}t_{ji}\right) + \left(\frac{1}{\sigma-1}-\frac{1}{\gamma}\right)\ln\left(f_{ij}f_{ji}\right)\right) + \gamma\left(\ln\left(t_{ii}t_{jj}\right) + \left(\frac{1}{\sigma-1}-\frac{1}{\gamma}\right)\ln\left(f_{ii}f_{jj}\right)\right) + \varepsilon_{ij}.$$

(iv) Gravity in Melitz and Ottaviano (2008)

Melitz and Ottaviano (2008) also model heterogeneous firms. But in contrast to Melitz (2003) and Chaney (2008), firms face fixed costs of market entry, f_E, that can be interpreted as product development and production start-up costs. When exporting, firms only face variable trade costs and no fixed costs of exporting. The model is based on non-CES preferences that give rise to endogenous markups. More specifically, markups tend to be low in large markets with many competitors. Their multiple country model leads to the following gravity equation:

$$(13)\quad x_{ij} = \frac{1}{2\delta(\gamma+2)} N_E^i \psi^i L^j \left(c_d^j\right)^{\gamma+2} \left(t_{ij}\right)^{-\gamma},$$

where δ is a parameter from the utility function that indicates the degree of product differentiation with a higher δ meaning a higher degree of differentiation. N_E^i is the number of entrants in country *i*. ψ^i is an index of comparative advantage in technology with a high value meaning that entrants in country *i* have a high chance of obtaining good productivity draws. L^j denotes the number of consumers in country *j*. c_d^j is the marginal cost cut-off above which domestic firms in country *j* do not produce. The intuition is that tougher competition in country *j*, reflected by a lower c_d^j, makes it harder for exporters from *i* to break into that market. Forming the ratio of domestic over bilateral trade flows yields

$$(14)\quad \tau_{ij}^{MO} = \left(\frac{t_{ij}t_{ji}}{t_{ii}t_{jj}}\right)^{\frac{1}{2}} - 1 = \left(\frac{x_{ii}x_{jj}}{x_{ij}x_{ji}}\right)^{\frac{1}{2\gamma}} - 1.$$

Fixed costs do not enter the trade cost wedge, τ_{ij}^{MO}, because all firms face identical entry costs, f_E, and no fixed costs of exporting. Variable trade costs are sufficient to induce selection into export markets because of bounded non-CES marginal utility. Equation (14) implies the gravity structure

$$(15)\quad \ln\left(x_{ij}x_{ji}\right) = \ln\left(x_{ii}x_{jj}\right) - \gamma\ln\left(t_{ij}t_{ji}\right) + \gamma\ln\left(t_{ii}t_{jj}\right) + \varepsilon_{ij}.$$

(v) Gravity in Deardorff (1998)

Finally, we note that Deardorff (1998) argues that in a Heckscher-Ohlin framework, trade frictions prevent factor price equalization so that for the large majority of goods, only one country is the lowest-cost producer. In the presence of trade frictions, trade in a Heckscher-Ohlin world therefore resembles trade in an Armington world.

In summary, the reason why our trade integration measure τ_{ij} is consistent with a broad range of trade models is related to the fact that they all lead to gravity equations that have a similar structure as equation (2). In a similar vein, Feenstra, Markusen and Rose (2001) as well as Evenett and Keller (2002) also show that gravity equations are consistent with various competing trade models. Intuitively, the gravity equation simply indicates how consumers allocate their expenditure across countries subject to trade frictions (Baldwin and Taglioni, 2006). Gravity equations arise regardless of why consumers want to buy goods from foreign countries. In an Armington world, consumers buy foreign goods because those goods are inherently different and consumers prefer variety. In a Ricardian world, countries produce goods according to comparative advantage and consumers buy foreign goods because they are cheaper. It turns out that the particular motivation behind foreign trade is not crucial to understand the role of trade frictions.

IV. Trade Costs over Time

We use equation (6) along with the trade and output data detailed in the appendix to construct bilateral trade costs for the 130 country-pairs in our sample. Lacking consistent data on domestic trade, we use GDP less aggregate exports instead. For the post-World War II period, it becomes possible to track how well this proxy performs by comparing it to domestic trade constructed as total production less total exports. The results are favorable in that although the level of bilateral trade costs is affected by the way domestic trade is measured, the change over time is remarkably similar (Novy, 2008). The value of the elasticity of substitution is set to eight which roughly corresponds to the midpoint of the range (5,10) as surveyed by Anderson and van Wincoop (2004).

Average trade cost series are generated for each of the three eras of globalization by regressing the constructed bilateral trade costs on a set of year fixed effects. This exercise is replicated for both global trade and six sub-regions: within the Americas, within Asia/Oceania, within Europe, between the Americas and Asia/Oceania, between the Americas and Europe, and between Asia/Oceania and Europe. Figures 2 through 4 track these averages over time. There, the averages have all been normalized to 100 for the initial observation in each period, i.e. 1870, 1921, and 1950, so that they are not strictly comparable in terms of levels across periods. Our goal instead is to highlight the changes within a given period.[7] We weight these averages by GDP to reduce the influence of country pairs which trade infrequently or inconsistently.[8]

Thus, for the first wave of globalization from 1870 to 1913, we document an average decline in international trade costs of thirty-three percent.[9] This was led by a fifty percent decline for trade between Asia/Oceania and Europe, probably generated from a combination of Japanese reforms that increased engagement with the rest of the world, the consolidation of European overseas empires, and radical improvements in communication and transportation technologies which linked Eurasia. And these gains were apparently not limited to the linkages between the countries of Asia/Oceania and the rest of the world as intra-Asian/Oceanic trade costs declined on the order of thirty-seven percent. Thus, the late nineteenth century was a time of unprecedented changes in the relative commodity and factor prices of the region as has been documented by Jeffrey G. Williamson (2006).

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[7] We are also trying to avoid pressing too hard on the assumption that the elasticity of substitution has remained constant over the entire 130 years under consideration.

[8] The obvious candidate for weights, the level of bilateral trade, is inappropriate in this instance. A quick look at equation (6) verifies that bilateral trade and trade costs are not independent. That is, a low trade cost measure is generated for a country pair with high bilateral trade, suggesting that the use of bilateral trade would impart systematic downward bias in the weighted average.

[9] The distribution of spikes in 1874 and 1881 in the "Asia" and "Americas-Asia" series, respectively, may seem odd. However, these are explained by the small number of underlying observations (N=7 and N=6, respectively) and can be attributed to sporadic trade volumes for Japan as it integrated—sometimes by fits and starts—into the global economy.

Bringing up the rear was intra-American trade with a still respectable average decline of nineteen percent. This performance masks significant heterogeneity across North and South America: trade costs within North America declined twenty-nine percent while trade costs between North and South America fell by only fifteen percent. Most likely, this reflects South America's continued orientation towards European markets and the fleeting connections uniting South America and North America—save the United States—at the time. Likewise, intra-European trade costs only declined twenty-one percent. This performance reflects the maturity as well as the close proximity of these markets. We should also note a substantial portion of the decline is concentrated in the 1870s. This was, of course, a time of simultaneously declining freight rates and tariffs as well as increasing adherence to the gold standard. In subsequent periods, the decline in freight rates was substantially moderated while tariffs climbed in most countries, dating from the beginning of German protectionist policy in 1879.

Turning to the interwar period from 1921 to 1939, we can see that the various attempts to restore the pre-war international order were somewhat successful at reining in international trade costs. A fitful return to the gold standard was launched in 1925 when the United Kingdom rejoined the club, and by 1928 most countries had followed its lead and stabilized their currencies. At the same time, the international community witnessed a number of attempts to normalize trading relations, primarily through the dismantling of the quantitative restrictions erected in the wake of World War I (Ronald Findlay and Kevin H. O'Rourke, 2007). As a result, trade costs fell on average by seven percent up to 1929. Although much less dramatic than the fall for the entire period from 1870 to 1913, this average decline was actually twice as large as that for the equivalent period from 1905 to 1913, pointing to a surprising resilience in the global economy of the time. The leaders in this process were again trade between Asia/Oceania and Europe with a fifteen percent decline and intra-European trade with a healthy ten percent decline.

On the other end of the spectrum, trade costs within the Americas and between the Americas and Europe barely budged, both registering a three percent decline. And again, these aggregate figures for the Americas mask important differences across North and South America: trade costs within North America ballooned by eight percent—reflecting the adversarial commercial policy of Canada and the United States in the 1920s (Orville J. McDiarmid, 1946)—while trade costs between North and South America declined by seven percent.

The Great Depression marks an obvious turning point for all the series. It generated the most dramatic increase in average trade costs in our sample as they jump by twenty-one percentage points in the space of the three years between 1929 and 1932. This, of course, exactly corresponds with the well-documented implosion of international trade in the face of declining global output (Angus Maddison, 2003), highly protectionist trade policy (Jakob B. Madsen, 2001), tight commercial credit (William Hynes, David S. Jacks, and Kevin H. O'Rourke, 2009), and a generally uneasy trading environment (League of Nations, 1933). Trade costs within Asia/Oceania, within Europe, and between Asia/Oceania and Europe all experienced the most moderate increases at eighteen percentage points each. Once again, trade costs within the Americas exploded—this time by a full thirty-five percentage points, driven more by the trade disruptions between North and South America (+38 percentage points) than within North America (+28 percentage points). Over time, though, trade costs declined from these heights just as global output slowly recovered from 1933 and nations made halting attempts to liberalize trade, even if on a bilateral or regional basis (Findlay and O'Rourke, 2007). Yet these were not enough to recover the lost ground: average trade costs stood thirteen percent higher at the outbreak of World War II than in 1921.

Finally, the second wave of globalization from 1950 to 2000 registered declines in average trade costs on the order of sixteen percent. The most dramatic decline was that for intra-

European trade costs at thirty-seven percent, a decline that is surely due to the formation of the European Economic Community and subsequently the European Union. The most recalcitrant performance was that for the Americas and Asia/Oceania, both of which registered small increases in trade costs over this period. In the former case, this curious result is solely generated by trade costs between North and South America which rose by twenty-two percent while trade costs within North America fell by an astounding sixty percent. This most likely reflects Argentina, Brazil, and Uruguay's adherence to import substitution industrialization up to the debt crisis of the 1980s and the reorientation of South American trade away from its very heavy reliance on the United States as a trading partner which had emerged in the interwar period. In the case of Asia/Oceania, the rise in trade costs is primarily generated by India which in its post-independence period simultaneously erected formidable barriers to imports and retreated from participation in world export markets. Curiously, this India effect is most pronounced for former fellow members in the British Empire, that is, Australia, New Zealand, and Sri Lanka.

Most surprisingly, the decline in trade costs in the second wave of globalization is mainly concentrated in the period before the late 1970s. Indeed, in the global and all sub-regional averages—save the Americas—trade costs were lower in 1980 than in 2000. In explaining the dramatic declines prior to 1973, one could point to the various rounds of the GATT up to the ambitious Kennedy Round which concluded in 1967 and slashed tariff rates by 50% and which more than doubled the number of participating nations (Kyle Bagwell and Robert W. Staiger, 2003). Or perhaps, it could be located in the substantial drops—but subsequent flatlining—in both air and maritime transport charges up to the first oil shock documented in Hummels (2007). In any case, this curious phenomenon demands further attention, but remains outside the scope of this paper.

V. The Determinants of Trade Costs

Having traced the course of trade costs over the past 130 years, we might do well to consider their likely determinants. This exercise serves two purposes. First, it addresses—albeit imperfectly—the natural question of what factors have been driving the evolution of trade costs over time. Second and more importantly, it helps establish the reliability of our measure of trade costs[10]—that is, are trade costs as constructed in this paper reasonably correlated with other variables commonly used as proxies in the literature? Trade costs in our model are derived from a gravity equation rather than estimated as is typically the case in the literature. Commonly, log-linear versions of equation (1) are estimated by substituting an arbitrary trade cost function for z_{ijt} and using country-pair fixed effects for the multilateral resistance variables. Such gravity specifications, to the extent that the trade cost function and the econometric model are well specified, could be used to provide estimated values of trade costs. In fact, such specifications have been highly successful in explaining a significant proportion of the variance in bilateral trade flows as demonstrated above. Nevertheless, there is likely a substantial amount of unexplained variation due to unobservable trade costs and, thus, potential omitted variable bias.

To be confident in our methodology, it is important that we show that our trade cost measure is related in sensible ways to standard proxies for international trade costs. Below, we demonstrate that this is the case. Consider the standard arbitrary function for trade costs that the vast majority of the gravity literature imposes

(16) $\tau_{ijt} = \alpha \ \text{dist}_{ij}^{\rho} \exp(x_{ijt}\beta + \varepsilon_{ijt})$,

[10] Appendix II also reports the results from comparing our trade cost measure with the residuals from a gravity equation including common annual fixed effects and country-specific annual fixed effects. As noted before, the growth in bilateral trade is driven by global factors common across all countries, factors within particular countries, and factors specific to country pairs such as trade costs. Thus, a regression of bilateral trade on common annual fixed effects and country-specific annual fixed effects will capture the first two elements while the residuals capture any pair-specific changes. The (absolute value of the) correlations between our preferred trade cost measures and these residuals are high, ranging from 0.53 to to 0.64.

where *dist* is a measure of distance between two countries, x is a row vector of observable determinants of trade costs, and ε is an error term composed of unobservables. We log-linearize (16), and the determinants we consider are the same as those in Section 2 and include the distance between two countries, the establishment of fixed exchange rate regimes, the existence of a common language, membership in a European overseas empire, and the existence of a shared border. In all regressions, we include time-invariant exporter and importer fixed effects and year fixed effects as well as a pair specific white noise error component. The reported regressions pool across all periods and then separate the data for the 130 dyads between 1870 and 1913, 1921 and 1939, and 1950 and 2000. The results are reported in Table 3.

Considering the pooled results first, we find that a one standard deviation rise in distance raises trade costs by 0.38 standard deviations. Fixed exchange rates, a common language, joint membership in a European empire, and sharing a border all decrease trade costs with the latter two coefficients being roughly double the estimated effect of fixed exchange rate or sharing a common language. This pooled approach demonstrates that standard factors that are known to be frictions in international trade are sensibly related to the trade cost measure. The results also show that the trade cost measure determines trade patterns in ways largely consistent with the gravity literature covering more geographically comprehensive samples (cf. Mitchener and Weidenmier, 2008, for the pre-World War I period; Eichengreen and Irwin, 1995, for the interwar period; and Rose, 2000, for the post-World War II period).

At the same time, the pooled approach masks significant heterogeneity across the periods. Here, we would like to highlight a few of these differences. First, fixed exchange rate regimes were noticeably stronger in the pre-World War I and post-World War II environments—a result consistent with the tenuous resurrection of the classical gold standard in the interwar period (Natalia Chernyshoff, David S. Jacks, and Alan M. Taylor, 2009). Second, a common language seems to have exerted a slightly stronger force (roughly 75%) on trade costs in the period from 1870 to 1913 than subsequently. Third, we are able to document a strongly diminished role for European empires in reducing trade costs: a coefficient of -0.46 from 1870 to 1913 is reduced down to -0.15 in the period from 1950 to 2000—a result which is again consistent with the recent work of Head, Mayer, and Ries (2008).[11] Finally, distance seems to have become more important in the post-1950 world economy, with the coefficient increasing by 50 percent as compared to 1870-1913 or almost tripling when compared to 1921-1939. This result is in line with Disdier and Head (2008) who find that the estimated distance coefficient has been on the rise from 1950 in their meta-analysis of the gravity literature. Whether this reflects upward pressures in transportation costs (Hummels, 2007), the regionalization of trade (Novy, 2006) or changes in the composition of traded goods remains an open question, but it does accord with the empirical evidence on the decreasing distance-of-trade from the 1950s (Matias Berthelon and Caroline Freund, 2004; Celine Carrère and Maurice Schiff, 2004).

One way to get a sense of the relative contribution of the five variables to the variation in trade costs is to compare the R-squareds from a battery of regressions as in the work of Kalina Manova (2008). Specifically, one can generate an upper bound for the contribution of, say, distance by re-estimating (16) with only that variable but no other controls. One can also generate a lower bound for the contribution of distance by using the difference between the R-squared from the fixed effects specification in the corresponding panel of Table 3 and a regression of trade costs with fixed effects on all variables of interest except distance. In Table 4, we report the results of running such regressions for each variable in each sub-period. Thus, we find that distance can explain between 2% and 14% of the variation in trade costs in the period

[11] Curiously, much of this decline had already been affected by the interwar period when the coefficient registers in at a value of -0.20.

from 1870 to 1913. What is apparent from Table 4 is that the relative contribution of the five variables remains highly consistent across the three sub-periods with distance potentially explaining the most variation and historical membership in European overseas empires the least variation. The results in Table 4 also confirm the increasing explanatory power of distance over time—and especially in the post-1950 period—and the decreasing explanatory power of fixed exchange rate regimes and the historical membership in European overseas empires hinted at above.

VI. Changes in Output versus Changes in Trade Costs

In order to determine what drives trade booms and busts, we now turn to a decomposition of the growth of trade flows in the three periods. Gravity equation (5) can be used to attribute changes in trade flows to changes in bilateral trade costs, changes in bilateral output, and changes in multilateral barriers or factors. To see this, rewrite equation (2) as

$$(17)\quad x_{ij}x_{ji} = y_i y_j \left(\frac{t_{ij}t_{ji}}{t_{ii}t_{jj}}\right)^{1-\sigma} \frac{x_{ii}x_{jj}}{y_i y_j},$$

where the last term in equation (17) represents the multilateral factors. We first log-linearize (17), then at the bilateral level we take the difference between levels in initial years (1870, 1921 and 1950) and end years (1913, 1939 and 2000), and finally we compute GDP-weighted averages across dyads. We report the results from this exercise in Table 5 below.

Although the percentage growth in trade volumes is highly comparable in the two global trade booms of the late 19th and 20th centuries at 486 and 484 percent, respectively, the principal driving forces are reversed. In the period from 1870 to 1913, trade cost declines account for a distinct majority (290 percentage points) of the growth in international trade, while in the period from 1950 to 2000 trade cost declines account for a distinct minority (148 percentage points) of trade growth. This is congruent with traditional narratives of the late nineteenth century as a period of radical declines in international transportation costs and payments frictions as well as studies on the growth of world trade in the contemporary world which suggest that such changes may have been more muted (cf. Baier and Bergstrand, 2001; Hummels, 2007).

At the same time, both periods encompassed a wide variety of experience. For 1870 to 1913, the average trade growth of 486 percent masks a relatively anemic growth of 324 percent within Europe versus an explosive growth of trade between Asia/Oceania and Europe of 647 percent. European trade growth was also evenly driven by output growth and trade cost declines while the overwhelming majority of growth of trade between Asia/Oceania and Europe was driven by trade cost declines. The former result is consistent with the fact that the majority of European communication and transport infrastructure was in place well before 1870 and that a "tariff backlash" in Europe increased trade costs (O'Rourke and Williamson, 1999). The latter result is consistent with the idea that core-periphery trade between 1870 and 1913 was subject to much more radical changes: the expansion of trading networks through pro-active marketing strategies in new markets, the development of new shipping lines, and better internal communications.

For 1950 to 2000, the results for intra-European trade is exactly reversed: it is now in the lead at 633 percent while intra-American growth lags at 363 percent. European trade growth was again equally driven by output growth and trade cost declines while in all other regions of the world changes in output dominate. The results for the Americas are consistent with the evidence on trade costs documented above for North and South America in light of the latter's drive to self-sufficiency under import-substitution-industrialization.

Finally, in explaining the interwar period, the role of trade costs is dominant. Based on output growth alone, one would have expected world trade volumes to increase by nearly 88 percent. The fact that they failed to budge clearly underlines the critical role of commercial policy, the collapse of the gold standard, and the availability of commercial credit in determining trade costs at the time. And yet again, the interwar trade bust was anything but uniform: there was impressive trade growth between the Americas and Asia/Oceania of 48 percent set against an actual contraction of trade between the Americas and Europe of 45 percent. Output growth dominated trade costs in the case of the Americas and Asia/Oceania while the opposite was true in the case of the Americas and Europe—indeed, the increase in trade costs implies that barring output growth trade between the two would have ground to an absolute halt.

Figure 5 which concentrates solely on the full sample results but further disaggregates the sub-periods down to the decadal level more clearly illustrates the forces at work in the interwar period: whereas the 1920s witnessed significant output-driven expansion in trade volumes, the 1930s gave rise to a demonstrable trade bust in light of meager, albeit positive output growth. In this sense, the 1930s shares with the 1990s the distinction of being the only periods in which output growth "over-predicts" trade growth. At the same time, the 1870s and the 1970s are the periods in which the relative contribution of trade cost declines to world trade growth was at its greatest.

VII. Conclusion

In this paper, we have attempted to answer the question of what has driven trade booms and trade busts in the past 130 years. Our main contribution has been—both in terms of theory and data—to consistently and comprehensively track changes in trade costs and the fortunes of the global economy by using a newly compiled dataset on bilateral trade. We have been able to relate our trade cost measures to proxies suggested by the literature such as geographical distance and tariffs, confirming their reliability. And we have been able to assign an overarching role for trade costs in the nineteenth century trade boom and the interwar trade bust. In contrast, when explaining the post-World War II trade boom, we identify a more muted role for trade costs. Unlocking the sources of this reversal remains for future work.

Appendix I: Data Sources

Bilateral trade: Trade was converted into real 1990 US dollars using the US CPI deflator in Officer, Lawrence H. 2008, "The Annual Consumer Price Index for the United States, 1774-2007" and the following sources:

Annuaire Statistique de la Belgique. Brussels: Ministère de l'intérieur.

Annuaire Statistique de la Belgique et du Congo belge. Brussels: Ministère de l'intérieur.

Annual Abstract of Statistics. London: Her Majesty's Stationery Office.

Barbieri, Katherine. 2002. *The Liberal Illusion: Does Trade Promote Peace?* Ann Arbor: University of Michigan Press.

Bloomfield, Gerald T. 1984. *New Zealand, A Handbook of Historical Statistics*. Boston: G.K. Hall.

Canada Yearbook. Ottawa: Census and Statistics Office.

Confederacion Espanola de Cajas de Ahorros. 1975. *Estadisticas Basicas de Espana 1900-1970*. Madrid: Maribel.

Direction of Trade Statistics. Washington: International Monetary Fund.

Historisk Statistik för Sverige. 1969. Stockholm: Allmänna förl.

Johansen, Hans Christian. 1985. *Dansk Historisk Statistik 1814-1980*. Copenhagen: Gylendal.

Ludwig, Armin K. 1985. *Brazil: A Handbook of Historical Statistics*. Boston: G.K. Hall.

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Mitchell, Brian R. 2003b. *International Historical Statistics: Europe 1750-2000*. New York: Palgrave Macmillan.

Mitchell, Brian R. 2003c. *International Historical Statistics: The Americas 1750-2000*. New York: Palgrave Macmillan.

National Bureau of Economic Research-United Nations World Trade Data.

Statistical Abstract for British India. Calcutta: Superintendent Government Printing.

Statistical Abstract for the British Empire. London: Her Majesty's Stationery Office.

Statistical Abstract for the Colonies. London: Her Majesty's Stationery Office.

Statistical Abstract for the Principal and Other Foreign Countries. London: Her Majesty's Stationery Office.

Statistical Abstract for the Several Colonial and Other Possessions of the United Kingdom. London: Her Majesty's Stationery Office.

Statistical Abstract for the United Kingdom. London: Her Majesty's Stationery Office.

Statistical Abstract of the United States. Washington: Government Printing Office.

Statistical Abstract Relating to British India. London: Eyre and Spottiswoode.

Statistical Yearbook of Canada. Ottawa: Department of Agriculture.

Statistics Bureau Management and Coordination Agency. 1987. *Historical Statistics of Japan, vol. 3*. Tokyo: Japan Statistical Association.

Statistisches Reichsamt. 1936. *Statistisches Handbuch der Weltwirtschaft*. Berlin.

Statistisk Sentralbyrå. 1978. *Historisk statistikk.* Oslo.

Tableau général du commerce de la France. Paris: Imprimeur royale.

Tableau général du commerce et de la navigation. Paris: Imprimeur nationale.

Tableau général du commerce extérieur. Paris: Imprimeur nationale.

Year Book and Almanac of British North America. Montreal: John Lowe.

Year Book and Almanac of Canada. Montreal: John Lowe.

Fixed exchange rate regimes: Based on data underlying Meissner, Christopher M. 2005, "A New World Order." *Journal of International Economics* 66(3): 385-406; and Meissner and Nienke Oomes (forthcoming), "Why Do Countries Peg the Way They Peg?" *Journal of International Money and Finance*.

GDP: Maddison, Angus. 2003. *The World Economy: Historical Statistics*. Paris: Organization for Economic Cooperation and Development.

Distance: Measured as kilometers between capital cities. Taken from indo.com

Appendix II: The Reliability of the Trade Costs Measures

In a further attempt to establish the reliability of the trade cost measure used throughout this paper, here, we present the results of comparing these measures to the residuals of a very general gravity estimating equation. Earlier we argued that bilateral trade growth can be attributed to changes in the global trading environment which affect all countries proportionately—for instance, global economic growth which stimulates international trade; changes in the characteristics of individual countries—for instance, changes in domestic productivity; and changes at the bilateral level including the trade costs facing individual country-pairs—for instance, the introduction of a fixed exchange rate regime between two countries. To this end, the following regression equation was estimated:

(A.1) $\ln(x_{ijt}x_{jit}) = \delta_t + \alpha_{it} + \alpha_{jt} + \varepsilon_{ijt}$,

Thus, the first term captures changes in the global trading environment which affect all countries proportionately while the second and third terms captures changes in the characteristics of individual countries over time. The residual term thereby absorbs all country-pair specific changes in bilateral trade, including changes in trade costs.

The correlation between the logged values of our trade cost measure and these residuals is consistently high: -0.64 for the period from 1870 to 1913; -0.62 for the period from 1921 to 1939; and -0.53 for the period from 1950 to 2000. We note that the correlation, being negative, is correctly signed. For example, if Germany and the Netherlands experiences a particularly large volume of trade in a given year relative to past values or contemporaneous values for a similar country-pair—say, Germany and Belgium—then the residual should be positive as the linear projection from the coefficients will underpredict the volume of trade between Germany and the Netherlands for this particular year. However, the primary means by which trade is stimulated in our model, holding all else constant, would be a lowering of bilateral trade costs between the two countries. Thus, lower trade costs should be associated with higher volumes of trade (when evaluated at the sample means), generating a negative correlation between our trade cost measure and the residuals from equation (A.1).

Tables A.1 through A.3 display the two series (plotted by country-pair in chronological order). Naturally, the magnitudes are somewhat different, but with appropriate adjustment for the scale, it is clear that the correspondence between the two series is high, albeit not perfect.

Figure A.1: Residuals versus trade costs, 1870-1913

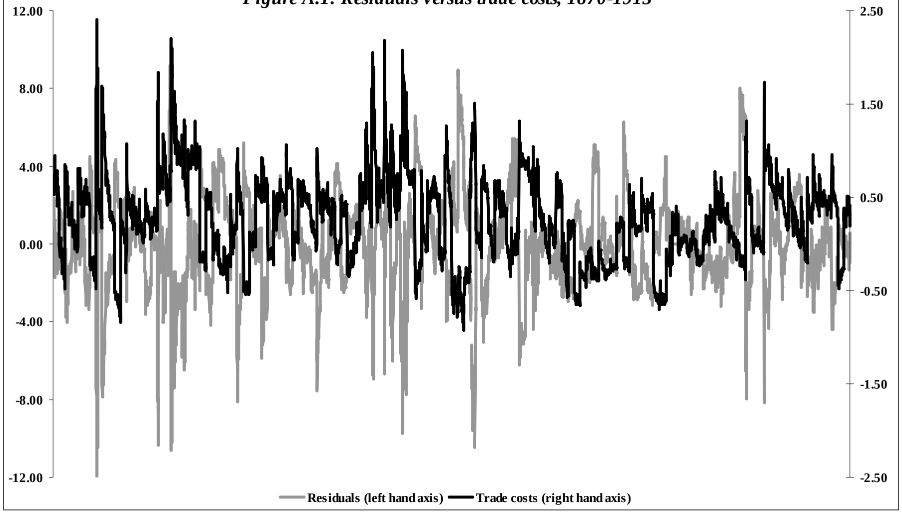


Figure A.2: Residuals versus trade costs, 1921-1939

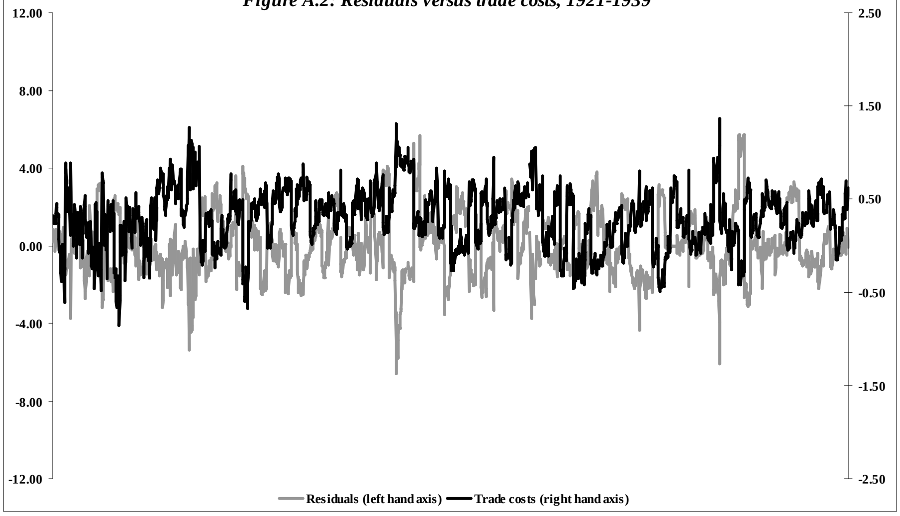
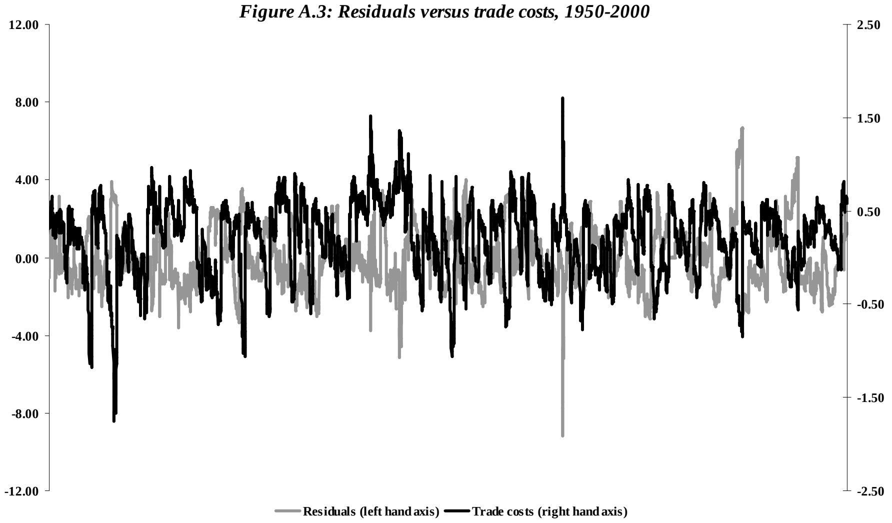


Figure A.3: Residuals versus trade costs, 1950-2000



Appendix III: Sensitivity to Assumptions on the Elasticity of Substitution

Figure A.4: Annual Change in Logged Bilateral Trade Costs, Canada and the United States, 1870-2000

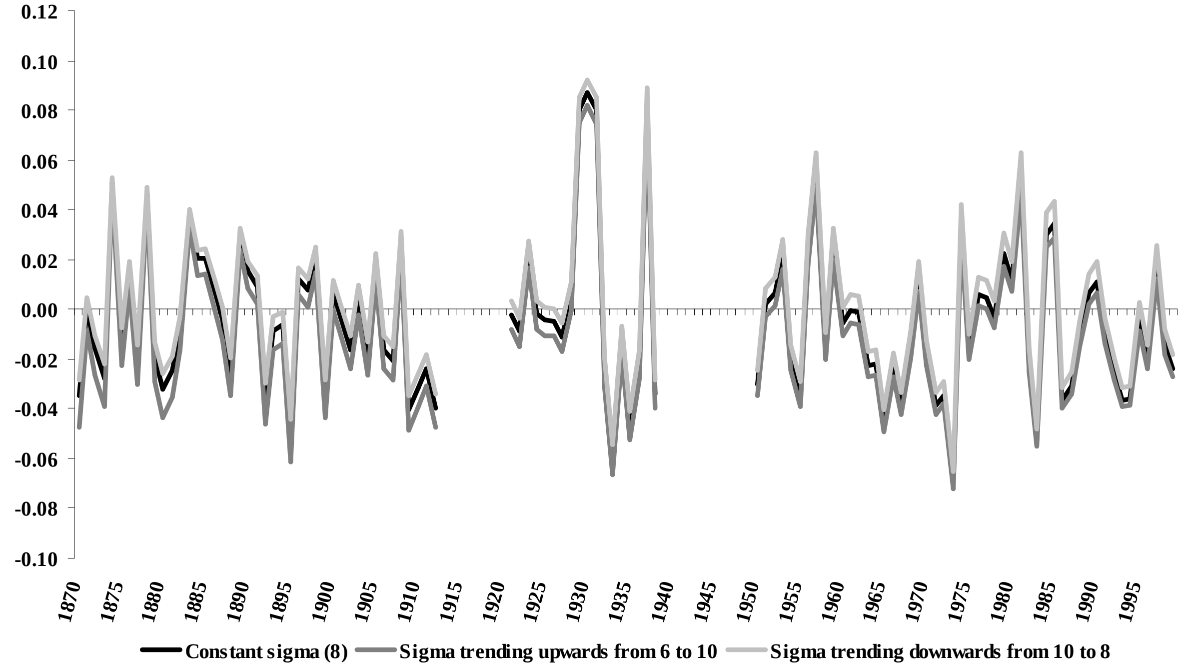


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Figure 1: Sample Countries (in white)

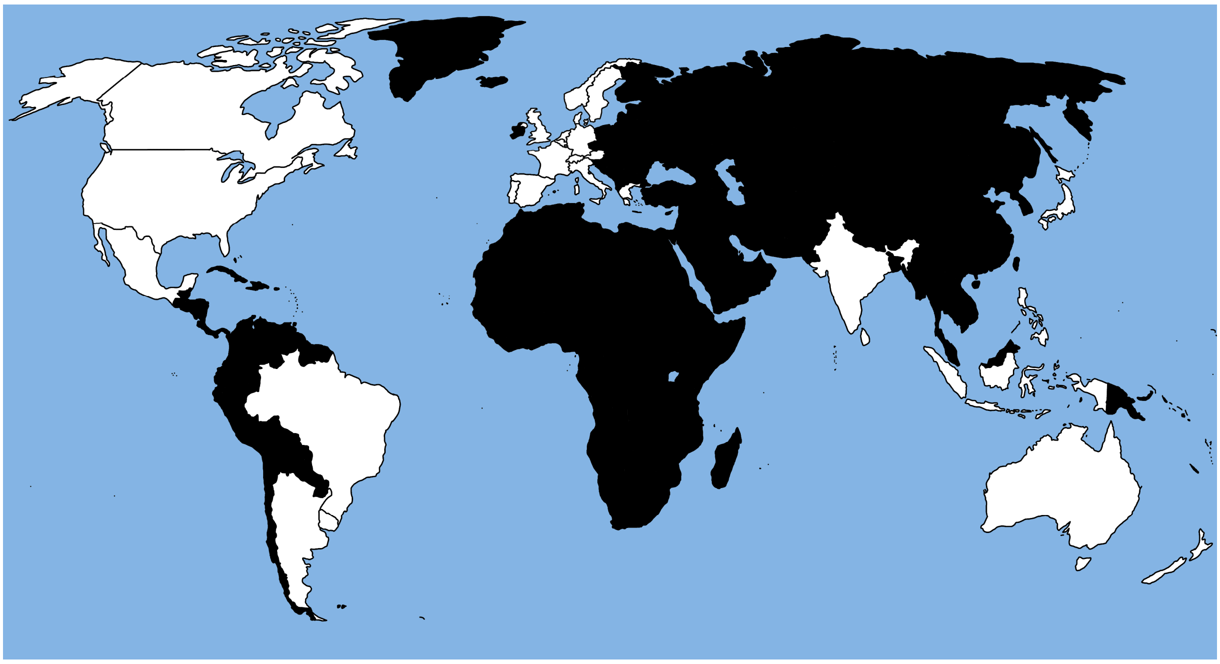


Table 1: Summary Statistics

	1870-1913			1921-1939			1950-2000		
	N	Mean	Std. Dev.	N	Mean	Std. Dev.	N	Mean	Std. Dev.
Bilateral trade	5709	36.13	4.17	2468	37.62	3.03	6628	40.91	3.53
Trade costs	5709	0.26	0.45	2437	0.28	0.31	6628	0.20	0.39
GDP	5709	20.85	1.74	2468	22.38	1.61	6628	25.13	1.93
Distance	5709	8.04	1.19	2468	8.04	1.19	6628	8.04	1.19
Exchange rate volatility	5709	0.50	0.50	2468	0.22	0.41	6628	0.08	0.28
Common language	5709	0.16	0.37	2468	0.16	0.37	6628	0.16	0.37
Imperial membership	5709	0.10	0.30	2468	0.09	0.29	6628	0.09	0.29
Shared border	5709	0.12	0.32	2468	0.12	0.32	6628	0.12	0.32

Table 2: Gravity in Three Eras of Globalization

Panel A: With country fixed effects

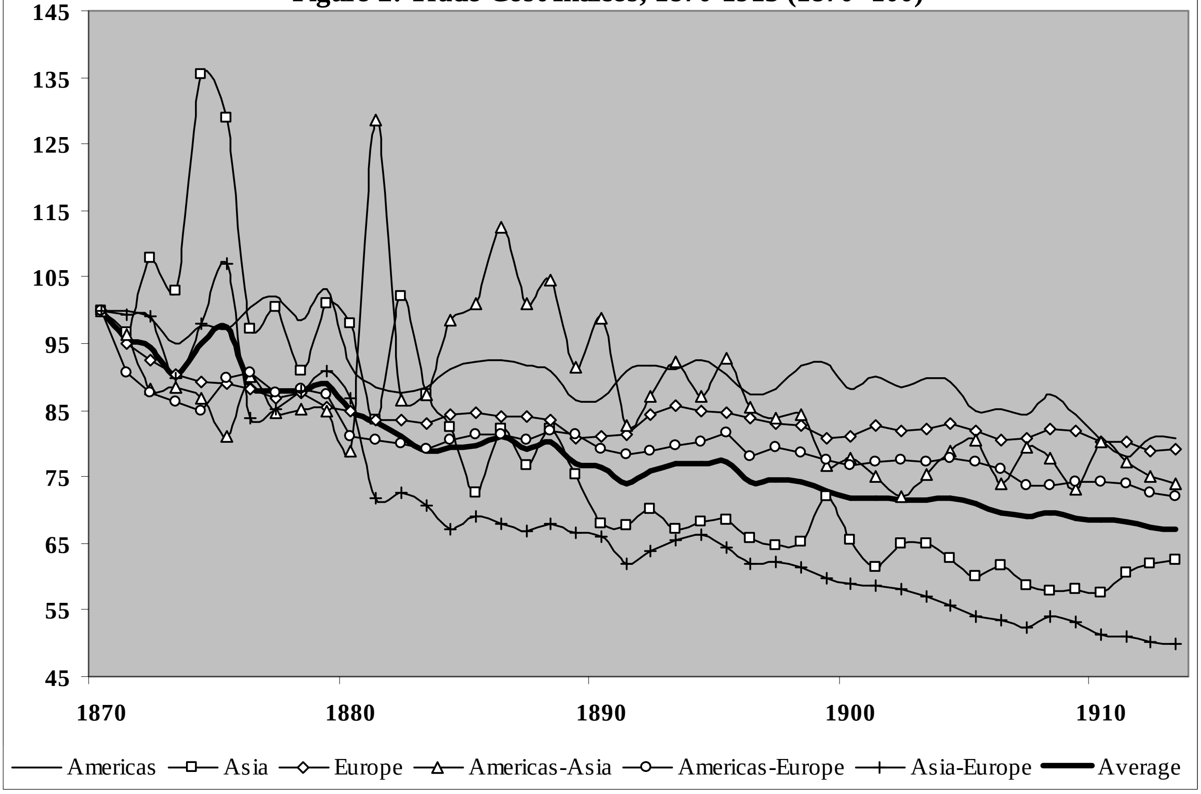
	1870-1913			1921-1939			1950-2000		
	Coefficient	Std .Err.		Coefficient	Std .Err.		Coefficient	Std .Err.	
GDP	1.57	0.05	***	0.94	0.11	***	1.48	0.02	***
Distance	-0.89	0.05	***	-0.50	0.05	***	-1.22	0.03	***
Fixed exchange rate regime	0.74	0.09	***	0.43	0.07	***	0.47	0.08	***
Common language	1.16	0.11	***	0.53	0.11	***	0.33	0.07	***
Imperial membership	3.51	0.19	***	1.49	0.17	***	1.35	0.10	***
Shared border	1.91	0.10	***	1.87	0.11	***	1.31	0.06	***
Observations	5709			2468			6628		
R-squared	0.7520			0.7809			0.8777		

Panel B: With country-specific annual fixed effects

	1870-1913			1921-1939			1950-2000		
	Coefficient	Std .Err.		Coefficient	Std .Err.		Coefficient	Std .Err.	
GDP	-	-		-	-		-	-	
Distance	-0.76	0.05	***	-0.46	0.05	***	-1.22	0.03	***
Fixed exchange rate regime	0.54	0.17	***	0.35	0.15	***	0.81	0.09	***
Common language	1.15	0.12	***	0.44	0.11	***	0.29	0.07	***
Imperial membership	3.35	0.22	***	1.40	0.18	***	1.34	0.09	***
Shared border	2.02	0.11	***	1.94	0.11	***	1.31	0.05	***
Observations	5709			2468			6628		
R-squared	0.7869			0.8126			0.9297		

NB: Country and year fixed effects not reported; robust standard errors; *** significant at the 1% level.

Figure 2: Trade Cost Indices, 1870-1913 (1870=100)



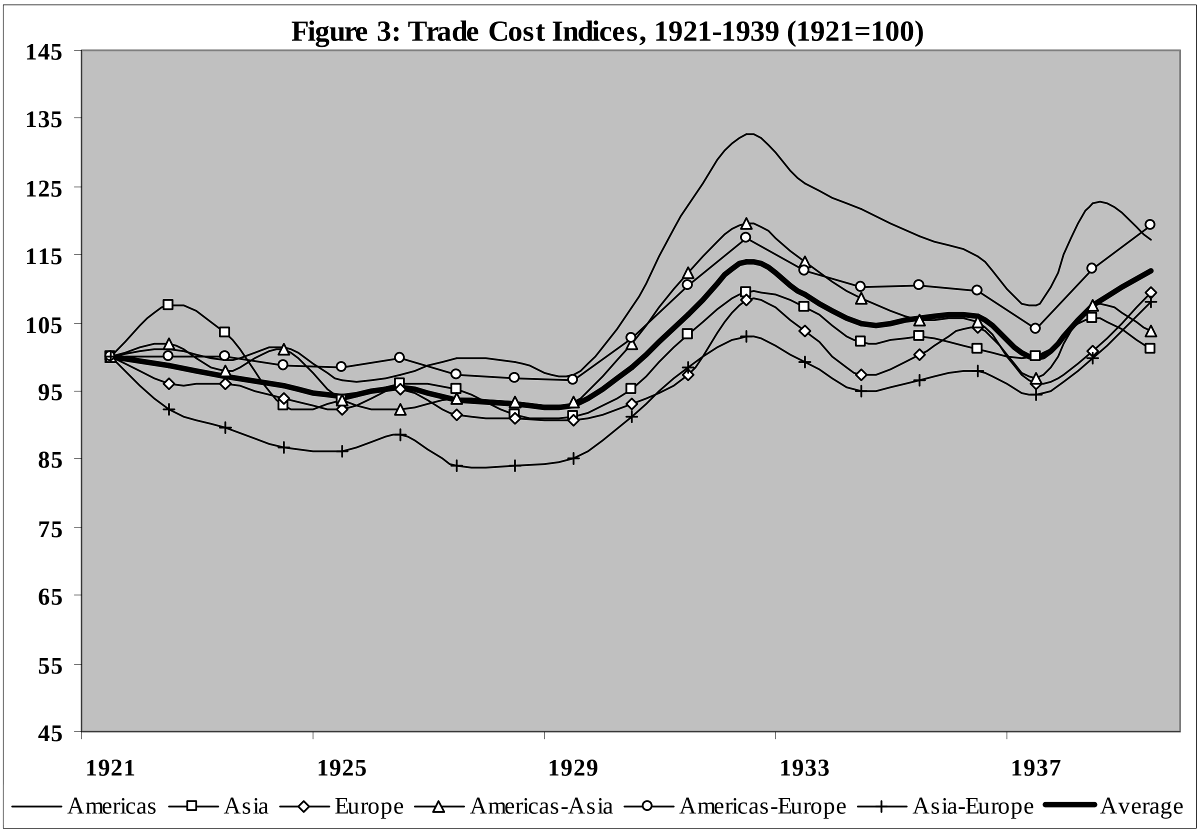


Figure 3: Trade Cost Indices, 1921-1939 (1921=100)
145
135
125
115
105
95
85
75
65
55
45
1921
1925
1929
1933
1937
Americas
Asia
Europe
Americas-Asia
Americas-Europe
Asia-Europe
Average

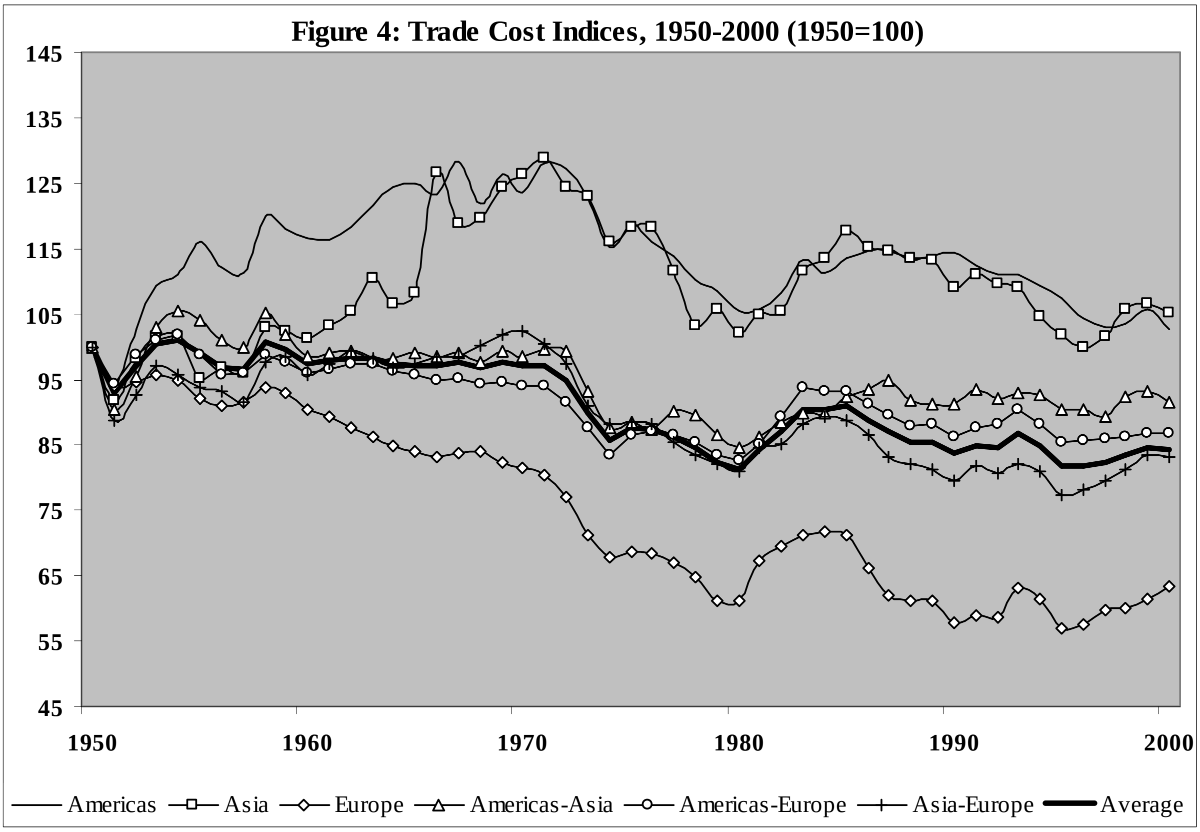


Figure 4: Trade Cost Indices, 1950-2000 (1950=100)
145
135
125
115
105
95
85
75
65
55
45
1950
1960
1970
1980
1990
2000
Americas
Asia
Europe
Americas-Asia
Americas-Europe
Asia-Europe
Average

Table 3: Determinants of Trade Costs in Three Eras of Globalization

	Pooled			1870-1913			1921-1939			1950-2000		
	Coefficient	Std .Err.		Coefficient	Std .Err.		Coefficient	Std .Err.		Coefficient	Std .Err.	
Distance	0.13	0.00	***	0.11	0.01	***	0.06	0.01	***	0.17	0.00	***
Fixed exchange rate regime	-0.04	0.01	***	-0.08	0.01	***	-0.04	0.01	***	-0.09	0.01	***
Common language	-0.11	0.01	***	-0.14	0.01	***	-0.08	0.01	***	-0.08	0.01	***
Imperial membership	-0.28	0.01	***	-0.46	0.02	***	-0.20	0.02	***	-0.15	0.01	***
Shared border	-0.26	0.01	***	-0.29	0.01	***	-0.26	0.01	***	-0.22	0.01	***
Observations	14774			5709			2437			6628		
R-squared	0.6464			0.7215			0.6891			0.8220		

NB: Country and year fixed effects not reported; robust standard errors; ***/**/** significant at the 1%/5%/10% level.

Table 4: Upper- and Lower-bound Estimates of Percentage of Explained Variation in Trade Costs

	1870-1913		1921-1939		1950-2000	
	Upperbound	Lowerbound	Upperbound	Lowerbound	Upperbound	Lowerbound
Distance	0.1362	0.0191	0.1267	0.0145	0.4513	0.0668
Fixed exchange rate regime	0.0968	0.0033	0.0597	0.0016	0.0028	0.0024
Common language	0.0411	0.0044	0.0565	0.0027	0.0230	0.0017
Imperial membership	0.0366	0.0276	0.0118	0.0057	0.0103	0.0043
Shared border	0.1139	0.0224	0.1035	0.0375	0.2213	0.0178

Table 5: Decomposition of Trade Booms and Busts, 1870-2000

			Contribution of change in trade costs (GDP weighted)		Contribution of growth in output (GDP weighted)		Contribution of growth in income similarity (GDP weighted)		Contribution of change in multilateral factors (GDP weighted)		Average growth of international trade (GDP weighted)
1870-2000	**Full sample**	**(n = 130)**	**326%**	**+**	**744%**	**+**	**-16%**	**+**	**-25%**	**=**	**1029%**
	Americas	(n = 6)	162	+	886	+	14	+	-1	=	1061
	Asia/Oceania	(n = 7)	436	+	610	+	51	+	-24	=	1074
	Europe	(n = 56)	330	+	590	+	23	+	-38	=	904
	Americas-Asia/Oceania	(n = 6)	511	+	832	+	-47	+	-28	=	1268
	Americas-Europe	(n = 35)	281	+	808	+	-56	+	-22	=	1011
	Asia/Oceania-Europe	(n = 20)	386	+	601	+	28	+	-30	=	985
1870-1913	**Full sample**	**(n = 130)**	**290%**	**+**	**225%**	**+**	**-11%**	**+**	**-18%**	**=**	**486%**
	Americas	(n = 6)	151	+	331	+	0	+	-19	=	463
	Asia/Oceania	(n = 7)	434	+	105	+	29	+	-11	=	557
	Europe	(n = 56)	176	+	177	+	-6	+	-23	=	324
	Americas-Asia/Oceania	(n = 6)	339	+	281	+	-48	+	-9	=	564
	Americas-Europe	(n = 35)	297	+	273	+	-26	+	-18	=	524
	Asia/Oceania-Europe	(n = 20)	497	+	146	+	20	+	-16	=	647
1921-1939	**Full sample**	**(n = 130)**	**-87%**	**+**	**88%**	**+**	**4%**	**+**	**-6%**	**=**	**0%**
	Americas	(n = 6)	-115	+	82	+	14	+	9	=	-10
	Asia/Oceania	(n = 7)	-36	+	58	+	12	+	0	=	34
	Europe	(n = 56)	-65	+	103	+	-2	+	-16	=	20
	Americas-Asia/Oceania	(n = 6)	-37	+	78	+	6	+	2	=	48
	Americas-Europe	(n = 35)	-132	+	86	+	7	+	-6	=	-45
	Asia/Oceania-Europe	(n = 20)	-50	+	85	+	1	+	-6	=	30
1950-2000	**Full sample**	**(n = 130)**	**148%**	**+**	**353%**	**+**	**8%**	**+**	**-25%**	**=**	**484%**
	Americas	(n = 6)	16	+	347	+	7	+	-7	=	363
	Asia	(n = 7)	-27	+	448	+	-14	+	-15	=	391
	Europe	(n = 56)	331	+	332	+	7	+	-38	=	633
	Americas-Asia	(n = 6)	84	+	356	+	29	+	-25	=	444
	Americas-Europe	(n = 35)	125	+	343	+	5	+	-23	=	450
	Asia-Europe	(n = 20)	185	+	386	+	2	+	-28	=	544

Figure 5: Trade Growth versus Output Growth (in %)